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DEPARTMENT OF COMMERCE

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OF THE BUREAU OF STANDARDS

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RADIO AIDS TO CIVIL AIRWAYS

The bureau has now in operation two experimental radio stations for aeronautic work carrying on active development on aids to air navigation. These two stations are located at College Park, Md., a suburb of Washington, D. C., and Bellefonte, Pa., which is located on the transcontinental airway midway between New York and Cleveland. The services of both stations are available to all aircraft able to make use of them.

At College Park there is a directive radiobeacon which has heretofore been equipped to send signals of the aural interlocking variety. Recently this beacon has been rebuilt to send in addition signals modulated at two low frequencies necessary for the visual indicator system that the bureau has recently developed. The College Park station is equipped with other special types of equipment for the sending of signals for experimental purposes. At Bellefonte the directive radio beacon is being remodeled so that it can send signals for use of the visual system in addition to the aural system. By May 15 three airplanes of the National Air Transport (Inc.), using the Bellefonte station, and three airplanes of the Pitcairn Aviation (Inc.), using the College Park station, will be equipped with suitable radio-receiving sets, including visual indicators, so that practical flying tests by these air-mail contractors may be carried out. Much valuable information is expected to result following the inauguration of these service flights.

College Park station is also equipped to transmit telephone or telegraph messages to airplanes. This station,

which is remotely controlled from the field, is available for experimental work through the courtesy of the American Telephone & Telegraph Co. The Bellefonte station is also provided with a remotely controlled 1 kw. set whereby telephone or telegraph messages can be sent to airplanes in flight. The practical operation of the handling of weather broadcasts to aircraft in flight by radiotelephony is to be included in the service flights mentioned, using these two stations.

The beacons operate in the frequency band 285 to 315 kc. and the telephone stations in the band 315 to 350 kc. These are allocated to air service by the 1927 International Radio Convention. For the present the beacons are adjusted to the frequency of 290 kc. and the telephone stations to 333 kc.

The directive radiobeacon is a special kind of radio station, usually located at an airport, just off the landing field. Instead of having a single antenna like an ordinary radio station, it has two loop antennas at an angle with each other. Each of these emits a set of waves which is directive—that is, it is stronger in one direction than others. When an airplane flies along the line exactly equidistant from the two beams of radio waves, it receives signals of equal intensity from the two. If the airplane gets off this line, it receives a stronger signal from one than the other.

The indicator connected to the receiving set on the airplane shows when the signals from the two beams are received with equal intensity by means of two vibrating reeds which are tuned to different modulating frequencies used on the two antennas at the directive radiobeacon station. When the beacon signal is received, the two reeds vibrate. The tips of these reeds are white in a dark background, so that when vibrating they appear as a vertical white line. The reed on the pilot's right is tuned to a frequency of 65 cycles and the one on the left to 85 cycles. It is only necessary for the pilot to watch the two white lines produced by the vibrating reeds. If they are equal in length, he is on his correct course. If the one on his right becomes longer that the other, the airplane has drifted off the course to the right (into the region where there is more of the 65 cycles). If he drifts off the course to the left, the white line on the left becomes longer.

The visual indicator system comprises a small indicator unit and a receiving set weighing between 12 and 16 pounds, with batteries weighing an additional 16 pounds. Very successful flights have been made up to 135 miles. To a large extent the device is little affected by interference. It is only partially affected by airplane engine ignition interference. Such interference does not change the operating characteristic of the indicator signal, but merely reduces the distant range from the beacon station. The system was recently demonstrated to representatives of the various Government departments.

During the latter part of 1927 several flights were made from Bellefonte in order to test the reliability of the directive type of beacon. There were both day and night flights. It was found that at night up to 50 miles from the beacon the directions were reliable; between 50 and 75 they were usually accurate, but uncertain at times; from 75 to 100 they were frequently unreliable; and beyond 100 the beacon could not be used. No such discrepancies were found during daylight hours. Two solutions are under investigation. Placing the beacons closer together and using a vertical antenna on the aircraft are expected to assist greatly. The greatest use of the beacon is within 30 miles of the field, where it is always reliable. A paper describing these night effects in detail will be published in an early issue of the Proceedings of the Institute of Radio Engineers.

Special receiving sets and antennæ for use on airplanes in connection with the beacon system have been developed. They are even simpler than those in use hitherto. The familiar trailing wire, with its possible dangers and its direc-

tive effect, introducing apparent variation of the course, is eliminated. It is replaced by a short vertical metal rod. The use of this improved antenna is made possible by a special receiving set which is highly sensitive, light in weight, and exceptionally proof against the engine ignition interference. This receiving set and antenna system can be used to receive telegraphy, telephony, and aural interlocking beacon signals, or to operate the visual indicator mentioned. The visual indicator plugs into the set in place of headphones. No other change is required.

While there are no commercial receiving sets at present available which are suitable for use on aircraft at the new frequencies for the air services, close cooperation is being maintained between the bureau and several commercial companies working on various problems related to radio aids for air navigation. It appears that suitable receiving sets and auxiliaries will soon be offered on the market. Publications describing the bureau's work on radio aids to air navigation in detail are in preparation. Announcement will be made in this bulletin when this material is available.

CALCULATION OF ANTENNA CAPACITY

A paper just issued by the bureau gives a discussion of methods and formulas for the calculation of the capacity of various common types of antennas. In the past two different basic methods have been used for such calculations, but the two methods have not always given the same result. The present paper shows that results of calculations by the two methods agree if appropriate formulas are used. One method, however, is the more general and useful. A set of working formulas for calculating the capacity of the more common types of antennas is developed. Tables of constants for facilitating numerical calculations are given, together with tables for the capacity of single-wire horizontal and vertical antennas and two-wire antennas. This paper, Bureau of Standards Scientific Paper No. 568, Methods, Formulas, and Tables for the Calculation of Antenna Capacity, by F. W. Grover, may be obtained for 20 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.

WEIGHTS AND MEASURES CONFERENCE REPORT

Technical News Bulletin No. 122 (June, 1927) contained a brief account of the Twentieth National Conference on Weights and Measures. The complete report of this conference has just been issued as Miscellaneous Publication No. 80 of the Bureau of Standards. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 45 cents each.

Among the large number of problems incident to law enforcement and the technic of weights and measures which were considered by the conference and are fully reported in this publication may be mentioned the following:

In an effort to promote uniformity of law, the conference some years ago adopted a so-called model law on the subject of weights and measures, recommended this to the various States for adoption, and it has been widely adopted throughout the country. Several amendments and additions were made to this proposed law at this conference in order to keep it up to date. The most important addition was specifying in the law, standards for the ton, and for a cord of cordwood; the former was made 2,000 pounds for all purposes, the latter 128 cubic feet.

A code of specifications and tolerances for bottles used in the retail sales of lubricating oil was tentatively adopted. Bottles are required to be of the recognized sizes of measures and to hold their marked capacity when filled up to a line permanently marked on the glass. The tolerances provided for are in excess only, since on account of the viscosity of the oil some inevitably adheres to the inside of the bottle regardless of how carefully it is drained.

An investigation conducted during the year demonstrated that certain liquid-measuring devices, especially some of the newer types coming on to the market, would deliver the represented quantities only after a period of drainage so long that it would not be adopted in ordinary filling-station use. It was also determined that measured liquid could leak back into the underground tank in some cases when the devices were not in proper condition without the fact that this leakage had occurred being disclosed to the operator or the purchaser. To safeguard full measure deliveries, therefore, specifications were incorporated specifying a proper drainage time, on the one hand, and requiring certain visible attachments, on the other.

Consideration was given to devices designed to deliver measured quantities of motor greases and similar products, a type of device not formerly taken up by the conference. It was demonstrated that devices in use are not always properly designed to perform the function for which they are intended, and that short measure results. This question was referred to a committee for study. Recommendations for specifications will be brought before the next meeting. This committee will also give consideration to the question as to whether taximeters can safely be operated from the transmission drive instead of by a star and pinion gear attached to the front wheel which has been the prevailing method in the past. It is the desire of operating companies to utilize the former method if official permission can be secured, since much less difficulty is encountered with this type of drive.

The subject of the proper manner of sale of ice cream, considered at former conferences, was disposed of by a resolution advocating the continued use of sales by liquid measure. However, to prevent unjustifiable reduction in the food value of the product per unit of measure it was advocated that the overrun—that is, the swell due to the incorporation of air in the product—be limited to 100 per cent.

One of the most difficult and important problems confronting the official is the efficient and adequate test of heavy-capacity scales, such as are used in the weighing of loaded automobile trucks. These scales are now designed to weigh very heavy loads, sometimes 30,000 pounds or more, and the testing equipment of the official has failed to keep pace with this development. New types of testing equipment for this work were described and discussed.

Another subject upon which papers were presented and a discussion had was methods adopted for regulation of new types of devices in various jurisdictions. Papers of officials demonstrated the necessity of preventing the sale of devices such that they would not be sealed when found in use, but also brought out the fact that the present method was not conducive to uniformity of action throughout the country. Manufacturers' statements demonstrated that the result was the necessity of making different devices for different jurisdictions, a practice which results in greatly increased costs. The conference adopted a resolution advocating Federal approval of type of apparatus and provided for a committee to draft a bill for introduction into the next Congress designed to procure this system of regulation.

CRITERIA OF GASOLINE VOLATILITY

In the early days of the petroleum industry, when most of the gasoline came from the Pennsylvania fields, it was tested and sold largely on the basis of gravity, and high Baumé gravity (high test) was a general indication of high volatility. But with the discovery and development of oil fields in other parts of the country gravity gradually lost its significance, for a gasoline from a California crude, for example, might have a considerably lower gravity (A. P. I.) than one from a Pennsylvania crude, and yet the former might be more volatile. The increasing use of cracked and of blended gasolines in recent years has removed any remaining significance which gravity had as an

indication of volatility, although a large amount of gasoline is still sold to the public on this basis.

Six years ago the Federal Government adopted specifications for gasoline which were based on the distillation test of the American Society for Testing Materials and not on gravity. This test gives an A. S. T. M. curve showing the temperatures at which various percentages of the gasoline are evaporated according to a definite procedure. These temperatures are, however, much higher than those necessary to vaporize the same gasoline in such air-gasoline mixtures as are supplied by the carburetor of an automobile engine. In order to study the volatility of gasoline under conditions more like those in the engine manifold, an equilibrium air-distillation apparatus was designed at the Bureau of Standards which gives curves indicating the temperatures at which various percentages of the fuel are evaporated under approximate manifold conditions.

Last year, on the basis of data for nine gasolines, it was reported in Technical News Bulletin No. 119 (March, 1927) that at 5 per cent and at 15 per cent evaporated the absolute temperatures on the A. S. T. M. and equilibrium air-distillation curves are related to each other by means of simple ratios. Since that time work on 25 gasolines has shown that similar ratios are obtainable at any percentage evaporated from 5 to 95 per cent. Thus, from the A. S. T. M. distillation test, which is in common use throughout the country, it is possible to compute volatility curves in terms of the mixture ratios used in the engine. A chart has been prepared for obtaining volatility data graphically, and a limited number of copies of this chart are available for distribution.

The general relations between the A. S. T. M. and equilibrium air-distillation curves do not hold at 100 per cent evaporated, for the reason that there is always a residue left in the A. S. T. M. test which is not evaporated, so that it is impossible to obtain the temperature of complete evaporation on the A. S. T. M. distillation curve. The temperature of complete evaporation on the equilibrium air-distillation curve can be obtained, however, and this temperature is called the dew point. On the basis of measurements with a large number of gasolines and with a variety of mixtures of air and fuel, a general relation was found between the dew-point temperatures of these mixtures and the temperature at 90 per cent evaporated on the A. S. T. M. distillation curve. This relation was checked by experimental work with a different type of apparatus which gave the dew-point temperatures directly.

The temperature of complete evaporation is of considerable importance on account of its bearing on the problem of normal engine operation; for example, it is advantageous to have a fuel with sufficient volatility so that the air-fuel mixtures drawn into the cylinders will not contain enough unevaporated gasoline to cause serious dilution of the crank-case oil. It is also advantageous because it reduces the necessity of adding heat to the mixture by means of auxiliary manifold heaters. On the other hand, the use of a fuel with too high a volatility in an engine equipped with manifold heaters may result in superheating the mixture and thereby cause loss in power.

The temperature at which 90 per cent of the gasoline is evaporated on the A. S. T. M. distillation curve is a real criterion of the volatility which is of interest under normal operating conditions. A gasoline with a low 90 per cent point will evaporate more readily in the engine manifold, and a classification of gasolines on the basis of their 90 per cent points would seem to be a logical step in the direction of giving the motorist real information about volatility. The end point on the A. S. T. M. distillation curve is frequently used for this purpose, but it is misleading as a criterion for complete volatility. Thus one gasoline may have a 450 end point and another a 400 end point and still both may have the same 90 per cent point, and hence would have the same volatility under normal operating con-

ditions. On the other hand, two gasolines with different 90 per cent points will differ as regards complete volatility even though both are "400 end point gasolines."

THERMAL CONDUCTIVITY STANDARDS

A number of different laboratories in the United States and Canada are engaged in testing and investigational work in the field of thermal insulation at ordinary temperatures. Most of these laboratories use the so-called "hot-plate" method of test, but at best it has been difficult to judge the agreement in results between the various laboratories, since the class of materials tested—that is, insulating materials—are not particularly definite and reproducible, and, in addition, test conditions vary from place to place.

As part of a cooperative program with the Celotex Co. an attempt is being made to determine the accuracy which can be expected from the various devices now in use for measuring thermal conductivity. A number of test specimens have been prepared which may be termed "thermal conductivity standards," and these are being furnished to the various institutions possessing "hot plate" conductivity apparatus.

The test specimens consist of slabs of homogeneous cork composition material 8 or 12 inches square, to the surfaces of which thermocouples are permanently fastened, so that the boards are in reality "conductimeters" or "heat meters." A regular thermal conductivity measurement, consisting of independent measurements of heat flow, thickness, and temperature difference between hot and cold plates, is made on a pair of boards, and, in addition, readings are taken of the thermocouples permanently fastened to the specimens. The last-named measurement gives a check on the accuracy of the heat-flow measurement, independent of errors made in the measurement of thickness or temperature difference between the plates of the apparatus.

The standard specimens are coated with waterproof varnish, but this treatment does not protect against slow changes in moisture content with changes in atmospheric humidity. The specimens are, therefore, always dried in an oven before each determination.

The results thus far obtained from a few laboratories show rather good agreement with those obtained at the bureau. To expedite the survey, a new hot plate has been constructed for use primarily in standardization work. In the design of this plate the aim has been to obtain the highest possible accuracy rather than to sacrifice in favor of simplicity of construction. The bureau will be glad to furnish standard conductivity samples to any laboratory wishing to cooperate in this work.

FIRE RESISTANCE OF SAND-LIME AND CONCRETE BRICK WALLS

A series of fire tests of brick walls was completed recently at the Bureau of Standards. The object was to determine the fire protection, strength, and stability under fire conditions of this construction. An item giving the results for clay and shale brick walls was published in Technical News Bulletin No. 124 (August, 1927). The present item gives the results for sand-lime and concrete bricks.

Materials and Test Specimens.—Sand-lime and concrete bricks from two sources for each were included. The harder sand-lime brick would be graded as medium under present specifications of the American Society for Testing Materials, and the other as soft, mainly on the score of absorption, the compressive strength on edge ranging from 1,690 to 4,720 lbs./in.^{2}, and the modulus of rupture from 460 to 930 lbs./in.^{2}. The concrete bricks would pass the present A. S. T. M. tentative specifications for concrete building bricks with some margin, the average compressive strength flatwise being 2,780 and 2,920 lbs./in.^{2} for bricks from the respective sources. The aggregate used for both the sand-lime and the concrete bricks was siliceous sand. The bricks were built into walls 16 feet long and 10 to 11 feet high for tests in the large furnace and 4 feet wide and 4 feet high for tests in the small furnace, 8 tests being made with

walls of each size. Sand-lime and concrete bricks also formed parts of six walls subjected to fire and water tests.

The walls were laid up with Portland cement-lime mortar consisting of 1:1¼:6 volume parts of cement, hydrated lime, and dry sand, respectively, which was mixed with water to the consistency required by the masons. The bricks were laid flat, as in common or running bond, with one full header course for every five stretcher courses. The greater number of walls tested in the large furnace were built by a masonry contractor, who was awarded the work on the basis of competitive bids, and the workmanship was apparently barely up to the average in building construction. The other walls were built by masons in the employ of the bureau, and the grade of workmanship, as indicated by the way in which the joints were filled and pointed, was probably a little above the commercial average.

Method of Testing.—The walls were built into movable frames, and for the test were placed to form one wall of the furnace chamber. Some of the walls were built solidly into the frames, which were rigid enough to restrain the greater portion of the expansion of the wall during test, thus duplicating conditions where fire division walls are built between heavy floors and columns. Six walls were tested under a working load of 160 lbs./in.^{2} of gross area, maintained constant during the fire test, to determine the adequacy in this particular. Other walls were built free from the containing frames at the sides and top, permitting free movement of the wall during test, which is representative of the unrestrained condition of walls in minor buildings, or the top story of walls in higher buildings, where light, nonfire resistive interior, and roof construction does not appreciably restrain the wall at the floor and roof lines.

The furnace temperatures were controlled to conform with standard American fire-testing practice, the fire exposure being continued in the fire-endurance tests until or past the time when certain given temperatures obtained on the unexposed side, unless failure under the applied load occurred earlier. In the fire and water tests the walls were exposed to fire for one hour, after which they were pulled away from the furnace and a hose stream from a 1⅛-inch nozzle under a water pressure of 50 lbs./in.^{2} applied over the hot side.

Stability and Load-Carrying Ability.—The deflections of restrained and loaded walls were toward the fire and attained a maximum at the center of the wall. For 8-inch walls the maximum deflections of the large walls averaged 2 inches and for the 12-inch walls 1¼ inches, at from 2 to 6 hours after the start of the test. For the unrestrained walls the maximum deflections took place at the top of the wall and were away from the fire, the average of maximums obtaining at the end of 6 hours being 9¼ inches for 8-inch walls. The recovery from deflections on cooling ranged from one-fourth of the maximums obtaining during test to full recovery.

No 8-inch walls failed because of excessive deflection or under the applied working loads. One 12-inch wall of soft, sand-lime bricks failed under the working load at a little before 10 hours after the start of the test through weakening of the brick on the fire side. It is probable that few fire conditions in buildings will give rise to fires as severe as 10 hours of the standard fire test.

Fire Effects on Brick and Masonry.—For the restrained walls, cracks on the side away from the fire of over one-sixteenth inch in width were rare. For the unrestrained walls cracks up to five-eighths inch were formed in 8-inch walls toward the end of the test, these being narrower or closed on the fire side. The headers were seldom found cracked in the central portion of the wall, so that the integrity of the wall as a building member was maintained.

Serious damage to the bricks was confined to those next to the fire except for tests lasting over six hours. Cracks parallel with the face of the wall were

formed in some of the bricks from ½ to 1½ inches from the fire side. Hard bricks were more susceptible to cracking than the softer bricks, although showing greater strength after the fire test. The full discussion of fire effects and possibility of reuse involves a greater amount of detail than can be given in the present item.

Fire Resistance Classifications.—According to present specifications for fire tests, the classification for load-bearing walls is based on ability to sustain the working load and to prevent temperature transmission through the wall to such an extent as to endanger combustible materials in contact with the unexposed side. The average temperature rise permitted is 139° C. (250° F.), or a maximum rise of 181° C. (325° F.) for any single point. The temperatures are measured under asbestos felt pads, four-tenths inch thick, placed against the unexposed side of the wall. The periods given in the table are determined by temperature transmission unless otherwise noted. The limit for the 12-inch walls is determined by load-carrying ability for walls made from some of the bricks. The periods given are within the lower range of values obtaining in the fire-endurance tests.

The factor of safety that should be applied to these fire-resistance periods depends on the variation in material and workmanship to be expected in building construction beyond that present in the tests. The drier condition of party and fire walls after years of service in the interior of heated buildings, as compared with that of the walls tested, and the increase in temperature on the unexposed side after the prescribed temperature limit was reached and the fire shut off would, of course, influence the choice. Some information on the extent of these effects was developed in the tests. The use of factors of safety of 1¼ to 1½ on the results of fire-endurance tests has been advocated. In so far as it concerns the constructions tested, the higher value does not appear to give a greater margin than necessary. On this basis a wall giving an ultimate fire resistance of three hours can be applied as protection against a fire condition equivalent to not more than two hours of the standard test, and a wall of nine hours' test rating to a fire condition estimated as not more severe than six hours of the test furnace exposure. The fire and water tests developed nothing that would change the conclusions based on the fire-endurance tests.

The periods apply for both bearing and nonbearing walls unless otherwise indicated. Those marked with a reference (2) in the following table are only to be used for nonload-bearing walls when the probable exposure approaches the period given in the table. However, such walls are safe for bearing purposes for lower periods. For bricks laid flatwise and for periods not exceeding six hours, either Portland cement, cement-lime, or lime mortar of volume proportions not leaner than 1:3, cement or lime, and sand, respectively, can be used. For walls having periods of over six hours, Portland cement or cement-lime mortar should be used.

When combustible floor members enter into solid walls, the periods are premised on the assumption that they project not more than 4 inches into the wall, and, where entering from both sides, that they are so placed and protected as to have not less than 4 inches of solid masonry between them.

Ultimate fire-resistance periods of solid concrete and sand-lime brick walls

Kind of brick	Nominal thickness	Building members projecting into wall	Fire-resistance period, hours
Concrete	8-inch unplastered	None, or incombustible	6½
	do	Combustible	3
	12-inch unplastered	None, or incombustible	15
	do	Combustible	12½
	8-inch unplastered	None, or incombustible	8
	do	Combustible	3½
Sand-lime	12-inch unplastered	None, or incombustible	[1] 10 [2] 15
	do	Combustible	[1] 10 [2] 13

[1] Determined by load-carrying ability.
[2] Determined by temperature transmission only and obtained by comparison with results of tests of concrete brick walls.

THERMAL EXPANSION OF FIRE CLAYS

The study of the fundamental qualities of representative fire-clay refractories and individual clays was described in Technical News Bulletin No. 125 (September, 1927).

The linear thermal expansion has been observed from room temperature to 900° C. by means of the interferometer on a total of 25 clays burned at 1,400° C. for five hours. These are the clays used in the manufacture of the 17 brands of fire brick included in this investigation. The clays may be classified according to the thermal expansion into four groups, as follows:

1. Eleven have a rapid rate below 200° C., due to the presence of tridymite and cristobalite, and a uniform rate from 200° to 900° C.

2. Three have rapid rates of expansion below 200° C. and at approximately 600° C., due to presence of the different types of silica.

3. Nine have a uniform rate from room temperature to 900° C.

4. Two have a uniform rate from room temperature to approximately 725° C., at which temperature the rate increased until 850° C. was reached, after which it decreased.

In comparing these data with those obtained on the brick in which the clays were used either singly or blended and which were previously reported it was noted that—

1. In four instances the rapid rate of expansion below 200° C. shown by the clays was not apparent in the bricks. It is possible that this difference is due to the blending of two or more clays which is favorable to the growth of mullite crystals at 1,400° C.

2. Two brands of fire bricks show a rapid rate of expansion at 600° C., which is not present in the individual clays. This expansion in the bricks is undoubtedly due to the nature of the grog added in the manufacturing process.

3. In two cases where bricks are manufactured from the same clay by both the stiff-mud and dry-press methods the expansion of the clay is higher than that observed on the brick of either type.

WORKABILITY OF PORTLAND-CEMENT PASTES

The study of workability of Portland-cement pastes has now included tests of three devices—the extrusion cylinder, the ball plasticimeter, and the capillary tube. The first device consists of a cylinder from which a piston forces the cement paste through an orifice, the piston moving at a constant speed.

The three methods have shown differences, in some cases very marked, in the behavior of various cements when tested in the form of neat cement pastes. Moreover, the relative order of the results is different for each of the three devices. It is apparent that this investigation must be continued to determine the extent to which the test method used influences the results obtained. Without this information no satisfactory comparison can be made of the relative workability of mortars and concretes prepared from these cements. It seems probable that the manner in which a cement is to be used should largely influence the choice of the method by which its workability is determined.

It is interesting to note that the ball plasticimeter and the capillary tube have both placed at opposite extremes of the groups of curves two cements submitted by one manufacturer. One of these cements was considered by the maker as highly plastic when used in concrete and mortars, while the other cement was thought to be of a decidedly opposite character.

BASE PLATES FOR EMLEY PLASTICIMETER

The Emley plasticimeter for the determination of the plasticity of hydrated lime was developed at the bureau and is fully described in Technologic Paper No. 169, Measurement of the Plasticity of Mortars and Plasters. The instrument has been adopted by the Federal Specifications Board and the American Society for Testing Materials as the standard for measuring the plasticity of hydrated lime. Those familiar with the plasticimeter will recall that an unglazed porcelain plate, 4 inches in diameter and 1 inch thick, is used to simu-

late the action with reference to absorption of the scratch and brown coats of plaster. It is obvious, and has been corroborated by test data, that the rate of absorption of the plate influences to a marked degree the "plasticity figure" of the lime. Unfortunately, the purchasers of plasticimeters have received plates differing in rate of absorption from those used at the bureau, which have the following rate of absorption over an area equal to that of the test specimen:

Time (in minutes)	Absorption
	ml
1	9
2	5
3	5
4	4
5	4

For some time the bureau, in cooperation with the makers of the plasticimeter, has been making an effort to obtain an unlimited supply of base plates of the proper characteristics. Only recently has success been achieved. About 1,200 plates have been received, which are being evaluated as rapidly as possible. To date those tested have a rate of absorption very close to those used at the bureau and are very uniform with respect to this property. On completion of the work of evaluating the rate of absorption of the plates they will be turned over to the manufacturer of the instrument, then those wishing them may obtain any number of plates of the proper characteristics, and platicity determinations by one operator will be comparable with those made by other operators or laboratories.

CONTROL OF CLAY SLIPS BY USE OF ELECTROLYTES

A study is being made of protective colloid action in the casting of clay slips at the Columbus branch of the bureau. Tannic acid and peat have been used to date. The addition of small amounts of tannic acid or peat to slips containing little or no carbonaceous matter has been found to decrease the amount of water necessary to make up the slips and to increase markedly the cross-breaking strength of inch bars from such slips. The composition of a typical body containing no organic matter is the following:

	Grams
Tennessee ball clay No. 7	100
Georgia china clay No. 4	400
Flint	300
Feldspar	200
Sodium carbonate	1.25
Sodium silicate	1.25

The addition of 0.2 per cent carbon in the form of tannic acid or peat (calculated as per cent of dry weight of body before the addition of water) was found to increase the cross-breaking strength of inch bars cast from such slips about 125 per cent and to decrease by 20 to 25 per cent the amount of water necessary to make up the slips. The addition of 0.05 per cent carbon in the form of peat or tannic acid gave approximately the same cross-breaking strength as the larger (0.2 per cent), but gave lower water economy. The addition of peat or tannic acid in concentrations considerably greater than 0.2 per cent decreased the rate of setting of the slips. The aim in adding protective colloid evidently should be to select such a concentration of protective colloid as will give a large cross-breaking strength of bars and maximum water economy without abnormally increasing the time of setting. The lower concentrations of peat and tannic acid (0.05 and 0.2 per cent) do not decrease the rate of setting of the slip. It is also possible that the addition of protective colloid will aid in preventing the "livering" of slips which have stood for some time.

At the present time the effect of tannic acid and peat is being tested, using only china clay, flint, and feldspar as the body. Both English and Georgia china clays are being used.

"TRUE" SPECIFIC GRAVITY OF FELDSPARS

Technical News Bulletin No. 129 (January, 1928) contained a report of

the study of the thermal expansion of the 19 commercial feldspars under investigation. The following report summarizes the study of the true specific gravity of the raw, partially fused, and fused feldspars. A Hubbard type pycnometer, closed with a polished glass disk to seal the capillary and prevent evaporation, was used in this study. Samples weighing approximately 5 grams were used. The weighings were made on a chemical balance sensitive to the fourth decimal. The pycnometer was dried at 110° C., the sample introduced, weighed, and evacuated under a bell jar. Freshly boiled distilled water sufficient to cover the sample was then added through a separatory funnel. Then the pycnometer was removed, more water added, the sample allowed to settle, and cooled to 20° C. ±0.1° in a constant temperature water bath. After the sample had settled and cooled the pycnometer was completely filled with water, wiped dry with a soft, clean cloth, and weighed.

The results shown in the following table indicate that the average values for the raw felspars vary from 2.615 for sample No. 1 (high soda feldspar) to 2.574 for sample No. 19 (high potash feldspar). These values compare favorably with those found by other investigators. Since there is a difference of only 2 per cent between the greatest and least specific gravities of the 19 feldspars, covering the field from albite to microcline, it is doubtful whether the determination of specific gravity will have any value as a practical test to determine the type of feldspar purchased.

For the determinations of the true specific gravity of the partially fused and fused feldspars the samples were pressed in mullite crucibles fired to cones 4, 8, 10, 12, 13, and 14, drawn at the desired temperature, and quenched in running water. The specimens were broken away from the crucibles, crushed between hardened steel surfaces, ground in an agate mortar, magnetic particles removed, passed through a No. 100 sieve, and the specific gravity determined.

The results show that the specific gravity of the feldspar decreases when fired to cone 4 and drops still more when fired to cone 8. When fired to cones 10, 12, 13, and 14 only slight differences are shown, indicating that the crystalline form has been nearly all converted to amorphous glass. The definite molecular structure of the feldspar crystal is evidently converted to leucite and glass on melting, as has been reported by Morrey and Bowen,[1] and the glass resulting from undercooling shows a drop in specific gravity and an increase in volume. The average increase in volume for a feldspar fired to cone 4 is 4 per cent, fired to cone 8 is 7 per cent, and fired to cone 10 is 9 per cent. This conforms to data obtained by other investigators.

Feldspar No.	True specific gravities of feldspars in terms of equal volumes of water at 20° C.						
	Raw feldspar	Fired to—					
		Cone 4	Cone 8	Cone 10	Cone 12	Cone 13	Cone 14
1	2.615	2.513	2.424	2.374	.....	.....	.....
2	2.613	2.517	2.422	2.407	.....	.....	.....
3	2.612	2.461	2.422	2.389	.....	.....	.....
4	2.614	.....	2.428	2.420	.....	2.413	.....
5	2.604	.....	2.412	2.407	.....	2.386	.....
6	2.602	.....	2.454	2.422	.....	2.393	.....
7	2.610	.....	2.444	2.403	.....	2.395	.....
8	2.595	.....	2.404	2.397	.....	2.388	.....
9	2.593	.....	2.411	2.394	.....	2.384	.....
10	2.598	.....	2.412	2.402	.....	2.400	.....
11	2.600	.....	2.406	2.397	.....	2.394	.....
12	2.598	.....	2.403	2.408	.....	2.377	.....
13	2.589	.....	2.426	2.411	2.410	.....	2.376
14	2.594	.....	2.435	2.414	2.396	.....	2.372
15	2.582	.....	2.430	2.401	2.387	.....	2.370
16	2.586	.....	.....	2.412	2.406	.....	2.374
17	2.572	.....	.....	2.409	2.400	.....	2.377
18	2.583	.....	.....	2.381	2.379	.....	2.376
19	2.574	.....	.....	2.397	2.375	.....	2.376

PROPERTIES OF SHEATHING PAPER

At the request of the National Lumber Manufacturers' Association, the bureau has entered into a cooperative study of sheathing papers with the object of formulating a standard specification for this important building material. This project is part of the association's general program of standardi-

[1] "The melting of potash feldspar," by G. W. Morrey and W. L. Bowen, Am. J. of Sci., Vol IV, July, 1922.

zation of building practice as regards wooden structures.

Practically no information on sheathing paper is available. The preliminary work, which has just been completed, consisted, therefore, of a survey of the products being used for this purpose and laboratory tests of representative samples.

Quite a variety of papers differing both as to composition and character are being used for sheathing. Some are composed of mixtures of wood and waste textile fibers, such as are used for roofing papers, while other consist entirely of the cheaper grades of wood fibers. The papers vary greatly in thickness and weight. Some are impregnated with tar or oily materials to render them resistant to moisture and to insects.

The primary function of sheathing paper is to minimize the infiltration of cold air. The air permeability of the samples was determined under a pressure corresponding to that of a 20-mile wind. Large differences in permeability were found, but in view of the relatively large air leakage around window casings and door frames, and that due to the frequent opening of doors and windows, and considering also that only 15 to 30 per cent of the total heat losses from dwellings are ascribed to infiltration of air from all sources, it seems doubtful if the differences in air permeability of various sheathing papers would cause differences of appreciable magnitude in heating costs. In other words, probably any sheathing paper which can be put in place whole will give equally good service as regards heat losses.

Sheathing paper, to have an appreciable influence on heat transmission through a wall by conduction, would have to possess a thermal conductivity much less than that of any known solid substance. Hence, it did not seem worth while to measure the conductivities of the papers.

In addition to strength sufficient to permit the paper being placed in position whole, a certain degree of water resistance is desirable, as paper is weakened by moisture, and moisture promotes mold. Much variation in these properties was found. In common with all building materials, resistance to the ravages of insects is no doubt important.

The association proposes to conduct some field experiments in order to correlate the laboratory test results with service results.

EFFECTS OF TEMPERATURE AND HUMIDITY DURING PREPARATION AND TESTING OF RUBBER COMPOUNDS

There will soon be available a report by the physical testing committee of the rubber division of the American Chemical Society on the effects of temperature and humidity during the preparation and testing of rubber compounds. This report presents complete data and final conclusions based on an investigation conducted at the Bureau of Standards in accordance with a program drawn up by the physical testing committee. A comprehensive study was made with five cures of five typical compounds, involving several thousand tests, in which the humidity, temperature, and periods of exposure were varied, both prior and subsequent to vulcanization. Photographs are included showing the apparatus used in conditioning the samples. Test methods are described in detail, and the results are given in 52 tables and 98 charts. Data obtained show that previous to vulcanization relative humidity has a pronounced effect upon the stress-strain relation, while that of temperature within the range studied is practically negligible. Differences due to relative humidity vary both in degree and kind with the ingredients used. Length of exposure of compounds has an appreciable effect. Subsequent to vulcanization, relative humidity has but slight effect, while that of temperature is pronounced. The effects due to temperature are not changed materially in the compounds studied by the compounding ingredients. Copies of this report will be available to those interested through the physical testing committee of the rubber division of the American Chemical Society and can be

obtained when issued by addressing the chairman, J. E. Partentheimer, Fisk Rubber Co., Chicopee Falls, Mass.

PERCEPTION OF SLIGHT COLOR DIFFERENCES

On page 1 of Technical News Bulletin No. 129, under the above heading, reference was made to an article as published in the January number of Oil and Fat Industries. Owing to an unavoidable delay this article was not published till the March number.

TIRE SIMPLIFICATION

A reduction in the number of automobile tire sizes from 24 to 16 was unanimously approved at the March meeting of the directors of the National Automobile Chamber of Commerce in New York City. The directors also adopted a suggestion that the Rubber Association of America and the Society of Automotive Engineers reach an early agreement on the 16 proposed uniform sizes.

ENVELOPE SIMPLIFICATION

The rapidly increasing use of the simplified invoice and of the standard bank check has made it important to have available a window envelope satisfactory for mailing these classes of documents. Envelope manufacturers are now supplying two envelopes to be used in the mailing of the simplified invoice form, as well as the standardized checks. These envelopes are of the same size, 3⅝ by 8⅝ inches. The difference is in the size and location of the window.

One has a window 1¼ by 4 inches, located ⅝ inch from the left-hand margin and $\frac{13}{16}$ inch from the bottom while the other has a window 1 by 5 inches, located ¾ inch from the left-hand margin and ⅞ inch from the bottom. Either of these envelopes can be used for the simplified invoice form or the standardized check.

The Post Office Department will incorporate in its new schedule, effective January 1, 1929, a "No. 6" envelope, 3⅝ by 8⅝ inches, with a standard window 1¼ by 4 inches, located ⅝ inch from the left-hand margin and $\frac{13}{16}$ inch from the bottom.

PORT CHESTER ADOPTS BUILDING CODE

The recently completed building code of Port Chester, N. Y., follows the arrangement recommended by the building code committee of the Department of Commerce for use in the case of small communities.

Employing this arrangement avoids omission or duplication of items, and the requirements are presented in a manner which represents the mature opinion of experts on the subject. Uniform methods of presenting requirements are generally admitted to save architects and contractors much time and energy. The arrangement recommended by the committee is contained in the publication, Recommended Practice for Arrangement of Building Codes, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 10 cents per copy.

ACTIVITIES OF COMMERCIAL STANDARDS GROUP

Sidewalk Lights.—The standing committee on sidewalk, floor, and roof lights has reaffirmed Simplified Practice Recommendation No. 49 for another year, commencing March 1, 1928. A survey of the operations of the industry during 1927 showed an excellent degree of adherence amounting to 94 per cent.

Paving Bricks.—The standing committee on vitrified paving brick has reaffirmed Simplified Practice Recommendation No. 1 for another year. A survey of the industry to ascertain the degree of adherence to this recommendation showed an average degree of 93 per cent.

Loading Platforms.—Manufacturers of this commodity have requested the division of simplified practice to cooperate in organizing a general program of reduction in variety of dimensions. Platforms, or "skids," for handling various materials have been used for many years by large industrial firms in and around their own plants, but within a relatively brief period certain industries have accomplished enormous savings, particularly in cost of loading and unloading freight shipments, by shipping goods

from plant to plant on platforms. A few railroad companies have also developed this method for handling stores and supplies between stores points on their own lines. The practice of shipping goods in this way is rapidly growing, hence the need for nationally accepted standards of dimensions is becoming recognized by railroads, shippers, and manufacturers of platforms and lift trucks. Hundreds of different commodities may be loaded and shipped on platforms, with resulting economy in cost of packing and handling and in many cases more advantageous loading in cars. Platforms are already being used to carry sacked goods, such as sugar, cement, flour, etc., also for hundreds of manufactured products ranging from flat paper stock to automobile parts. One large company has saved 77 per cent in cost of packing material and 93 per cent in cost of loading and unloading by shipping its product on platforms from one plant to another.

Simplification of loading platform dimensions will involve simplification of hand and electric lift trucks as well. It will in many cases be found profitable to simplify certain kinds of industrial trucks and trailers, crane and hoist equipment, and various other material-handling devices, in order to secure the maximum economies possible through a universally recognized system of standards.

Stoddard Solvent.—After several months of intensive study and laboratory experiment the standing committee on Stoddard solvent has reached a unanimous agreement that the amount of unsaturated hydrocarbons permitted in Stoddard solvent should be limited to 5 per cent, to be determined in accordance with a specific method of test. A sketch of the modified Babcock bottle has been prepared and the specification revised accordingly. It is planned to distribute within the next few weeks this proposed commercial standard to all interested producers, distributors, and consumers for final acceptance.

Porcelain Plumbing Fixtures.—The advisory committee on porcelain plumbing fixtures has completed its study of dimensional standards and limitation of variety for staple porcelain (all-clay) plumbing fixtures. The resulting recommendation indicates a variety of 87 items to be retained as staple as compared to the present total variety of 622. Dimensional standards are recommended for each of the 87 varieties and will be included in the agenda to be circulated with invitation to producers, distributors, and consumers to attend a general conference at 10 a. m., Tuesday, May 22 1928, in room 704, Commerce Building Washington, D. C. All those interested in porcelain plumbing fixtures are invited to attend.

Clinical Thermometers.—A general conference of producers, distributors, and users of clinical thermometers approved a commercial standard which established the minimum requirements in the manufacture of thermometers of this character. The new production will begin October 1, 1928. One year (to March 30, 1929), will be allowed for the clearance of existing manufacturer's stocks.

NEW PUBLICATIONS

Additions to Supplementary List of Publications of the Bureau of Standards (beginning July 1, 1927)

Scientific Papers[2]

S568. Methods, formulas, and tables for the calculation of antenna capacity; F. W. Grover. Price, 20 cents.

S569. Generator for audio currents of adjustable frequency with piezo-electric stabilization; A. Hund. Price, 10 cents.

S570. Thermal expansion of alloys of the "stainless iron" type; P. Hidnert and W. T. Sweeney. Price, 10 cents.

Technologic Papers[2]

T362. Creep in five steels at different temperatures; H. J. French, H. C. Cross, and A. A. Peterson. Price, 15 cents.

[2] Send orders for publications under this heading, with remittance, only to Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States, Canada, and Mexico); 40 cents (foreign).

T363. Endurance and other properties of rail steel; J. R. Freeman, jr., R. L. Dowdell, and W. J. Berry. Price, 35 cents.

T365. Statical hysteresis in cycles of equal load range; G. H. Keulegan. Price, 5 cents.

Circulars[2]

C111 (3d ed.). United States Government master specification for paint, lithopone, interior, white and light tints, flat or eggshell finish (semi-paste and ready mixed). Price, 5 cents.

C139 (2d ed.). United States Government master specification for cells and batteries, dry. Price, 5 cents.

C146 (Supersedes C76). Light metals and alloys; aluminum, magnesium. Price, $1.10.

Simplified Practice Recommendations[2]

(Elimination of Waste)

R63. Metal spools (for annealing, handling, and shipping wire). Price, 5 cents.

R68. Metal and fiber flash-light cases. Price, 5 cents.

R70. Salt packages. Price, 5 cents.

R72. Solid section steel windows. Price, 20 cents.

R74. Hospital and institutional cotton textiles. Price, 5 cents.

Building and Housing[2]

BH10. A city planning primer; by Advisory Committee on Zoning. Price, 5 cents.

Miscellaneous Publications[2]

M80. Report of the twentieth national conference on weights and measures attended by representatives from various States held at the Bureau of Standards, Washington, D. C., May 24–27, 1927. Price, 45 cents.

Technical News Bulletin[2]

TNB132. Technical News Bulletin, April, 1928.

[2] Send orders for publications under this heading, with remittance, only to Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States, Canada, and Mexico); 40 cents (foreign).

OUTSIDE PUBLICATIONS[3]

On the influence of solar activity on radio transmission. L. W. Austin and I. J. Wymore; Proceedings, Institute of Radio Engineers (New York, N. Y.), p. 166; February, 1928.

Effect of temperature and other factors on the performance of storage batteries. G. W. Vinal and C. L. Snyder; preprint of paper to be presented at meeting of American Electrochemical Society (Columbia University, New York, N. Y.), April 26–28, 1928.

Star time or sun time. R. E. Gould; Jewelers' Circular (New York, N. Y.), Vol. 96, No. 6, p. 109; March 8, 1928.

The gaseous explosion reaction. F. W. Stevens; National Advisory Committee for Aeronautics (Washington, D. C.), Technical Report No. 280; March, 1928.

Progress report on headlight investigation. H. H. Allen; Journal, Society of Automotive Engineers (New York, N. Y.), Vol. XXII, No. 3, pp. 305–313 and 384–385; March, 1928.

The pyrophosphate method for the determination of magnesium and phosphoric anhydride. Alice W. Epperson; Journal, American Chemical Society (Easton, Pa.), Vol. 50, p. 321; February 4, 1928.

Equilibrium studies on alumina and ferric oxide and on combinations of these with magnesia and calcium oxide. W. C. Hansen and L. T. Brownmiller; Portland Cement Association Fellowship (Care of Bureau of Standards, Washington, D. C.) Paper No. 14; March 1928.

Studies on the system calcium oxide-alumina-ferric oxide. W. C. Hansen, L. T. Brownmiller, and R. H. Bogue; Portland Cement Association Fellowship (Care of Bureau of Standards, Washington, D. C.) Paper No. 13; February, 1928.

[3] "Outside publications" are not for distribution or sale by the Government. Request should be sent direct to publishers.

Plating discussed at Washington. William Blum; Brass World and Platers' Guide (New York, N. Y.), Vol. 24, No. 3, p. 69; March, 1928.

Determination of iron in glass sand. G. E. F. Lundell and H. B. Knowles; Journal of the American Ceramic Society (Columbus, Ohio), Vol. 11, p. 119; 1928.

Progress report on the effects of acids on leather. R. C. Bowker and E. L. Wallace; Journal American Leather Chemists Association (Ridgway, Pa.), Vol. XXIII, p. 82; March, 1928.

Textile research associate plan at the Bureau of Standards. Charles W. Schoffstall; Textile World (New York, N. Y.), Vol. LXXIII, No. 10, p. 21; March 10, 1928.

Bond between concrete and hollow tile. J. C. Oleinik; Engineering and Contracting (Chicago, Ill.), Vol. LXVII, No. 1, p. 19; January, 1928.

Twenty-five years of nonferrous electrometallurgy—15 years of electric brass melting. H. W. Gillett; Transactions of American Electrochemical Society (New York, N. Y.), Vol. 51, p. 101; 1927.

Weighing the earth. Paul R. Heyl; Scientific American (New York, N. Y.), Vol. 138, No. 3, p. 205; March, 1928.

Problems of research. George K. Burgess; address before the American Association of Dental Schools (Dr. De Los L. Hill, secretary, Atlanta, Ga.), March 27, 1928.

The following articles have been published in the series on "Practices and Standards," in the United States Daily (Washington, D. C.):

A. S. McAllister:
- Commercial specifications; March 3.
- Research and testing laboratories; March 5.
- Certification service; March 6.
- Federal Specifications Board; March 7.
- Labeling and checking systems; March 8.
- Aids for household purchases; March 9.

H. W. Gillett:
- Research on standards for metals and alloys; March 10.
- Specifications for steels; March 12.

P. L. Wormeley:
- Standards for rubber; March 13.
- Automobile tires; March 14.

B. W. Scribner:
- Paper standardizing activities; March 15.
- Standardization of paper; March 16.

E. C. Crittenden:
- Standards for electrical equipment; March 17.
- Specifications for electric lamps and dry batteries; March 19.

H. L. Whittemore:
- Research on metal structures; March 20.
- Research on locking screw threads and brick masonry; March 21.
- Welding machines and structures; March 22.

E. W. Washburn:
- Fundamental constants of physics and chemistry; March 23.
- The physical constants of materials; March 24.
- Examples of constants of physics and chemistry; March 26.

C. W. Schoffstall:
- Textile researches of the Bureau of Standards; March 27.
- Studies of textile materials; March 28.
- Studies of textile properties; March 29.

R. C. Bowker:
- Leather standardization; March 30.
- Researches concerning life of sole leather; March 31.

H. C. Dickinson:
- Automotive power plant research; April 2.
- Motor fuel problems; April 3.

P. H. Bates:
- Investigations in clay and silicate materials; April 4.
- Research on clay and silicate materials; April 5.

U.S. GOVERNMENT PRINTING OFFICE: 1928